

Appendix F

Isotopic and Hydrochemical Data

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This appendix includes isotopic and hydrochemical data that was acquired for DOE-sponsored site characterization studies for the former Basalt Waste Isolation Project (BWIP). The data listing is a subset of the full BWIP hydrochemistry database (Early et al. 1986). A limited amount of noble gas isotope data are provided in Section 4.0 of the main text of this report.

Analytical results are primarily for sampling conducted at discrete depths using a drill and test method. This involved drilling into the dense basalt interior below a zone to be tested and placing a packer in the dense interior of basalt overlying the target zone. After completing all hydrologic testing and sampling at a test zone it was sealed by injection of cement grout to prevent cross flow during drilling to the next lower aquifer. Quality control, analytical, and data collection methods for the groundwater sampling program are described in Early et al. (1986).

Data from a total of 25 Pasco Basin deep characterization wells (Figure F.1) are included, representing a wide range of structural, stratigraphic, and hydrogeologic conditions likely to be encountered in other locations across the Columbia Basin. Most of the original BWIP project wells were decommissioned and are no longer available for sampling or testing. Some key wells do remain that can be used for additional hydrologic and hydrochemical sampling purposes.

Water quality data from regional water supply wells are available from the USGS (e.g., Steinkampf and Hearn 1996). Use of the data set in this appendix together with regional water quality data, should allow inferences about hydrochemical conditions elsewhere in the region for site selection or characterization planning.

Explanatory notes for Table F.1 are as follows:

1. Results for replicates appear as more than one entry for an individual interval.
2. Stratigraphic interval designations are as follows: W = Wanapum Basalt; SMB = Saddle Mountains Basalt; GRB = Grande Ronde basalt; Tpr = Priest Rapids Member; Tr = Roza Member; Tfs = Frenchman Springs Member; V = Vantage Horizon (interbed); RRI = Interbed between Elephant Mountain and Pomona members; SI = Interbed between Pomona and Esquatzel Members; CCI = Interbed between Esquatzel and Astotin Members; Mabton = Interbed between Priest Rapids and Umatilla Members; N2 = 2nd Normal Magnetostratigraphic Unit of Grande Ronde Basalt; R2 = 2nd Reversed Magnetostratigraphic Unit of Grande Ronde Basalt; UMT = Umtanum flow of Grande

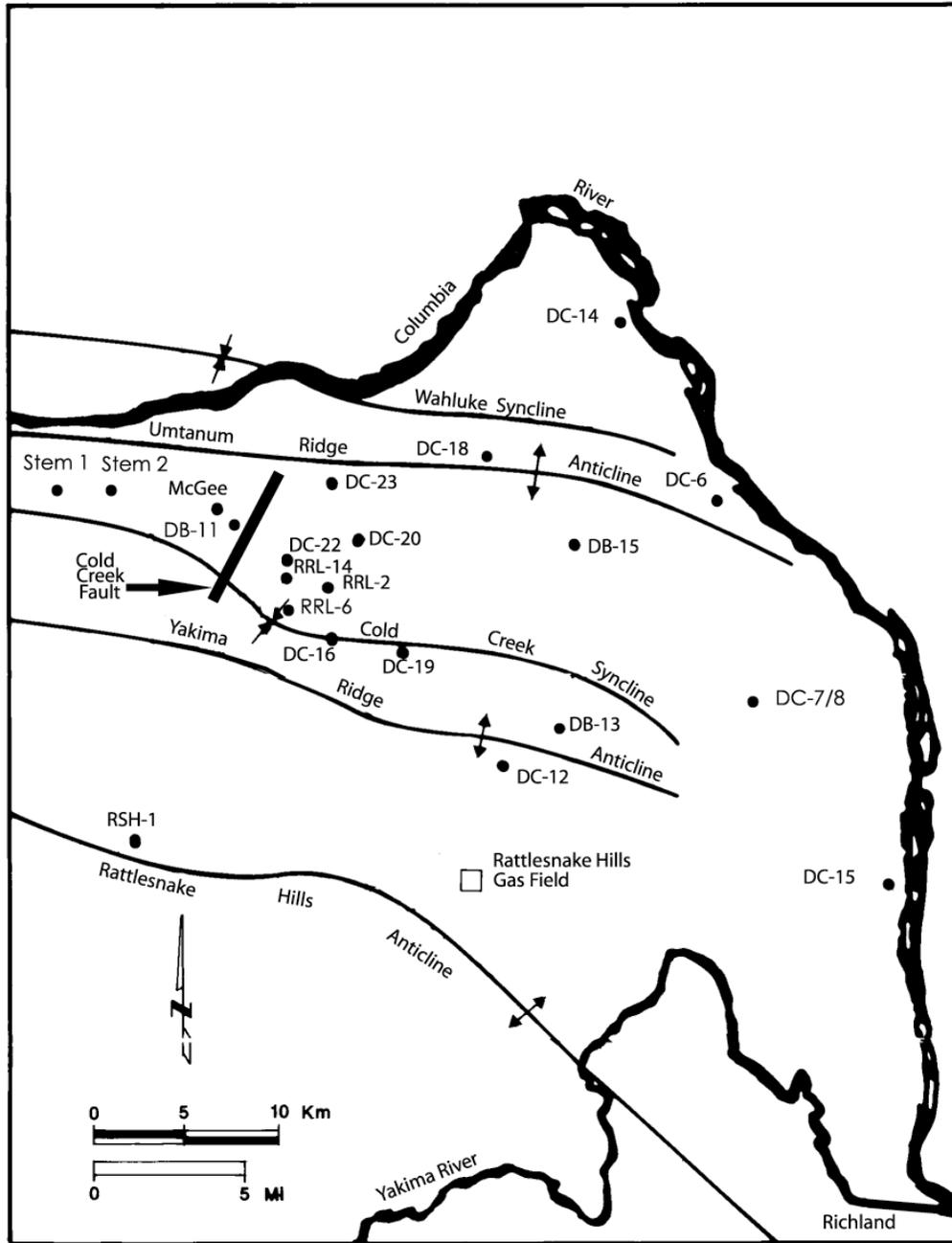


Figure F.1. Wells Drilled into Columbia River Basalt in the Pasco Basin

Ronde Basalt; RC = Rocky Coulee flow of Grande Ronde Basalt; COH = Cohasset flow of Grande Ronde Basalt; FZ = Fracture Zone. Depths for stratigraphic intervals are shown in the next-to-last column of Table F.1.

3. Most of the methane measurements were available only as relative mole percent from the mass spectrometry laboratory. Results for samples analyzed by gas chromatography using the purge and

trap method yielded both methane and nitrogen concentrations as well as relative mole percent data. Other indirect measures of methane abundances were made based on gas flow rate measurements from a gas separator barrel. The latter measurements also included relative compositional data for the gas phase. Methane abundance or concentration (mg/L) in those cases where only relative or mole percent data were available (Table F.1, columns 5 and 6) was calculated (column 4) from the following relationship based on gas solubility and Henry's Law:

$$\text{CH}_4 \text{ (mg/L)} = R \times S \times C \times K = R \times 10.2 \quad (1)$$

- R = Methane/nitrogen mole ratio
- S = Solubility of nitrogen in water (0.745 mM at 15°C)
- C = 16 mg/mM; moles/L to mg/L conversion
- K = Ratio of Henry's Law constants (0.855) for nitrogen/methane to correct for differential fractionation between liquid and gas phase during sampling of gas phase samples or vacuum extraction of liquid samples.

4. Measured methane concentrations using purge and trap gas chromatography or gas flow rate measurements from gas separator barrel are shown in column 7 of Table F.1. Comparison of direct measurements (column 7) with derived or calculated values (column 4) indicates reasonable agreement between the two methods.

Definitions for column headings and abbreviations used in Table F.1 are as follows:

- ORP - oxidation-reduction potential in mV
- ALK - alkalinity expressed as mg/L of calcium carbonate
- ¹³C(CH₄) - carbon-13 in methane expressed as the difference or "delta" or "del" relative to carbon-12 in units of parts per thousand, o/oo, relative to a standard
- D(CH₄) - deuterium (H-2) in methane, del o/oo (relative to hydrogen-1)
- ¹³(TIC) - carbon-13, isotopic composition of total inorganic carbon, del o/oo (relative to carbon-12)
- D(H₂O) - deuterium (H-2) in water, del o/oo (relative to hydrogen-1)
- ³⁴S(SO₄) - sulfur-34, isotopic composition of sulfate, del o/oo (relative to sulfur-32)
- ¹⁸O - oxygen-18 in water, del o/oo (relative to oxygen-16)

Table F.1. Selected Hydrochemical Data for Basalt Aquifers in the Pasco Basin (excerpted from Early et al. 1986)

Borehole	Sample	Strat. Interval	CH4, Calc mg/L	CH4 Mole%	N2 Mole%	CH4 mg/L	pH	TEMP (oC)	ORP (mil V)	ALK (mg/L)	Cl- (mg/L)	SO4= (mg/L)	F (mg/L)	B (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Mn (mg/L)	13C(CH4) del C13	D(CH4)	13C(TIC)	D(H2O)	34S(SO4)	18O	Interval (ft)	Method	Comment		
DB-11	B86-52	W Tpr	11	47.2	52.8	12	7.95	26.5	-250	140.0	4.2	ND	0.77	0.1	32.3	9.5	14.9	7.2	0.1	0.0	ND	ND	-10.0	-146	ND	-18.8	1020-1210	F			
			12	50.4	49.6	12																									
DB-13	P83-404	SMB-W Mabton	2	15.6	83.3		8.35	27.5	-300	153.0	4.6	0.14	0.49	0.02	54.20	10.10	9.00	2.03	0.07	0.03	ND	ND	-13.1	-144	ND	-17.5	1195-1292	P			
DB-15	CSG79-17	SMB-RR1	0	0.0	0.7		7.80	17.4	ND	98.4	7.7	37.1	0.3	0.0	44.4	10.4	18.9	4.9	0.0	0.0	ND	ND	-13.1	-152	-10.3	-17.2	150-222	P			
	CSG79-35	SMB-SI	0	0.0	27.0		7.80	19.6	ND	171.5	3.5	>1.2	0.8	0.0	80.7	7.1	2.3	0.4	0.1	0.0	ND	ND	16.0	-131	3.3	-17.9	370-422	P			
	CSG79-33	SMB-CCI	5	0.0	0.0		8.10	21.2	ND	174.0	7.2	>1.2	3.0	0.0	82.1	8.2	2.0	0.4	0.1	0.0	ND	ND	-15.5	-155	ND	-17.9	510-616	P			
	CSG79-15	SMB-Tus	39	29.2	7.6		8.20	22.0	ND	191.0	8.8	>1.2	3.0	0.1	89.9	10.6	1.6	0.5	0.2	0.1	ND	ND	-8.4	-150	23.7	-17.2	640-682	P			
	CSG79-39	SMB-Tuu	18	4.4	2.5		8.70	22.1	ND	208.0	ND	ND		0.1	97.1	10.6	1.9	0.5	0.2	0.1	ND	ND	-6.5	-153	ND	-17.3	680-754	P			
	CSG79-51	W-Tpr		274	96.3	3.6		9.50	24.0	ND	154.0	117.0	10.9	21.8	1.3	171.0	14.8	2.1	0.1	0.1	0.0	ND	ND	10.4	-135	3.2	-14.6	858-969	P		
				252	96.0	3.9																									
				257	96.1	3.8																									
	CSG79-85	W-Tpr		1	4.0	74.1		9.67	24.0	ND	157.0	105.0	9.6	19.1	1.3	176.0	15.6	3.0	0.6	3.3	0.1	ND	ND	8.2	-135	2.3	-14.9	909-969	SW		
				1	7.1	70.3																									
	CSG79-80	W-Tpr-Tr		229	94.9	4.2		9.63	26.9	ND	150.0	104.0	6.8	19.0	1.3	171.0	15.8	1.5	0.3	0.7	0.0	ND	ND	15.9	-132	ND	-14.8	1045-1105	SW		
				242	95.1	4.0																									
	CSG79-90			242	95.1	4.0																									
	CSG79-62	W-Tfs		78	83.1	10.9		9.38	20.6	ND	147.0	97.8	20.1	16.9	0.9	155.0	14.5	2.2	0.2	0.3	0.3	ND	ND	17.4	-131	ND	-15.1	1300-1343	P		
				123	92.0	7.6																									
	CSG80-35	W-Tfs		81	86.9	10.9		9.41	24.2	ND	159.0	109.0	16.3	18.4	0.9	170.0	18.6	4.3	0.2	6.3	0.1	ND	ND	16.0	-131	3.3	-14.9	1353-1373	SW		
110				89.8	8.3																										
CSG80-24	W-Tfs		178	94.4	5.4		9.53	25.4	ND	154.0	111.0	17.8	19.5	1.0	163.0	19.3	1.3	0.1	0.1	0.0	ND	ND	11.6	-132	ND	-15.2	1393-1443	SW			
			174	94.3	5.5																										
CSG80-77	W-Tfs		119	91.1	7.8		9.36	23.1	ND	169.0	102.0	18.4	17.6	0.8	161.0	18.3	1.4	0.2	0.1	0.0	ND	ND	13.3	-132	-3.0	-15.4	1450-1530	SW			
			110	90.5	8.4																										
CSG80-1	W-Tfs		171	94.3	5.6		9.44	25.1	ND	149.0	105.0	9.4	19.8	1.3	164.0	17.7	1.3	0.1	0.3	0.0	ND	ND	11.6	-129	ND	-15.0	1570-1683	SW			
			157	93.8	6.1																										
DC-05	CSG79-30	W-GRB (VI)	559	93.4	1.7		9.00	ND	ND	121.0	36.6	>0.5	14.0	0.5	278.0	23.9	13.0	0.1	0.4	0.0	ND	ND	-6.0	-132	ND	-14.2	2635-2714	P			
DC-06	CSG80-238	GRB-N2	0	0.6	98.0		10.20	41.0	-330	167.0	129.0	95.2		1.4	214.0	3.6	1.3	0.0	0.0	0.0	ND	ND	-21.4	-131	-6.2	-15.1	2260-4333	F			
	CSG80-15	GRB-UMT-N2	0	0.0	97.6		9.75	22.3	ND	83.0	211.0	189.0	35.4	1.2	361.0	4.1	2.1	0.0	0.0	0.0	ND	ND	ND	-126	3.6	-13.4	3242-3529	F			
	CSG80-29	GRB-N2	0	0.5	97.8		10.44	44.7	ND	152.0	96.3	79.5	34.0	1.5	209.1	1.7	1.0	0.0	0.0	0.0	ND	ND	-23.8	-125	-6.1	-14.5	3530-3824	F			
			0	0.9	96.8																										
	CSG79-58	GRB-N2-R2	0	0.8	97.5		10.00	41.4	ND	156.0	108.0	81.4	31.2	1.5	208.0	2.4	1.2	0.0	0.0	0.0	ND	ND	-23.3	-125	-1.7	-14.3	3691-3720	F			
0			0.8	97.6																											
CSG80-75	GRB-R2	0	1.6	96.0		10.60	43.2	ND	173.0	76.0	157.0	41.1	1.2	241.0	1.9	0.9	0.0	0.0	0.0	ND	ND	-21.7	ND	-13.2		4169-4333	F				
		0	2.0	96.0																											
DC-07	P82-23	GRB-UMT	0	4.3	91.3		9.89	25.3	-420	180.0	126.0	74.0	37.0	1.8	235.0	3.1	3.7	0.1	0.1	0.0	ND	ND	-23.0	-122	2.1	-14.5	2780-3948	P			
			0	4.4	92.0																										
	PR82-33	GRB-UMT	0	4.1	94.6		9.57	26.0	-440	160.0	137.0	83.0									-63	ND	ND	-126	ND	-14.3	2780-3948	P			
P82-10	GRB-UMT	1	5.2	91.0																											
DC-12	CSG80-80	W-Tpr	285	95.9	3.4		9.21	22.0	ND	137.0	103.0	2.8	10.1	0.9	145.0	15.1	1.1	0.1	0.1	0.0	ND	ND	12.8	-139	ND	-15.8	1217-1254	P			
	CSG80-100(-63)	W-Tpr	120	92.1	7.8		9.40	23.0	ND	140.0	96.5	ND									-44	ND	15.2	-134	ND	-15.8	1328-1364	P			

Table F.1. (contd)

Borehole	Sample	Strat. Interval	CH4, Calc mg/L	CH4 Mole%	N2 Mole%	CH4 mg/L	TEMP (oC)	ORP (mil V)	ALK (mg/L)	Cl- (mg/L)	SO4= (mg/L)	F (mg/L)	B (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Mn (mg/L)	13C(CH4) del C13	D(CH4)	13C(TIC)	D(H2O)	34S(SO4)	18O	Interval (ft)	Method	Comment	
			165	94.1	5.8																								
	CSG80-97	W-Tr-Tfs	181	92.7	5.2	9.46	22.6	ND	143.0	105.0	1.4	8.2	0.8	123.0	13.7	1.6	0.1	0.0	0.0	-43.7	ND	14.8	-136	ND	-15.9	1508-1534	P		
	CSG80-32	W-Tfs	119	91.9	7.9	9.52	23.8	ND	173.0	109.0	5.9		1.3	244.0	26.5	3.9	0.2	0.2	0.0	ND	ND	8.0	-133	ND	-15.6	1688-1710	P		
	CSG80-124	W-Tfs	112	91.5	8.3	9.38	24.1	ND	140.0	102.0	ND	9.8	0.8	131.0	16.3	1.1	0.1	0.1	0.0	-44.2	ND	15.2	-140	ND	-16.8	2050-2079	AL/IG		
	CSG80-234	GRB-N2	0	0.1	99.2	10.18	26.1	-300	211.0	104.0	15.4	12.6	0.8	157.0	15.7	5.0	0.1	0.0	0.2	ND	ND	2.5	-136	10.3	-16.1	2838-2864	AL/IG		
DC-14	CSG80-144	W-Tpr	0	0.0	98.6	8.84	24.1	ND	134.0	6.3	21.8	1.0	0.0	65.6	20.4	2.7	0.3	0.1	0.0	ND	ND	-12.2	-152	7.9	-19.6	1180-1192	F		
	CSG80-112	W-Tpr	0	0.0	98.7	8.75	28.3	-120	134.0	6.6	16.6	0.8	0.0	62.7	21.3	3.2	0.2	0.0	0.0	ND	ND	-12.2	-151	ND	-19.5	1285-1346	F		
	CSG80-155	W-Tfs	0	0.0	99.0	9.41	30.7	-215	146.0	6.9	20.5	2.2	0.1	76.1	11.9	1.2	0.1	0.0	0.0	ND	ND	-12.4	-149	2.8	-19.4	1575-1632	F		
	CSG80-104	W-Tfs	0	0.0	98.8	9.57	24.7	-120	149.0	5.1	ND	1.8	0.0	79.4	12.2	1.6	0.1	0.0	0.0	ND	ND	-12.3	-151	9.8	-19.4	1614-1708	F		
	CSG80-170	W-Tfs	0	0.0	98.7	9.38	34.5	-225	160.0	5.1	18.6	2.2	0.1	78.2	14.1	0.9	0.0	0.0	0.0	ND	ND	-12.7	-152	13.6	-19.4	1820-1875	F		
	CSG80-117	W-Tfs	0	0.0	98.8	9.65	36.2	-300	188.0	7.0	24.8	3.6	0.0	114.0	11.7	0.7	0.0	0.1	0.0	ND	ND	-12.9	-148	7.8	-18.6	1888-1983	F		
	PDG81-30	GRB-UMT	1	0.0	0.2	9.59	19.8	-280	109.0	231.0	145.0	40.6	1.0	316.0	8.1	4.1	0.0	0.0	0.3	ND	ND	-17.3	-115	2.7	-13.1	3060-3144	F		
	P82-8	GRB	0	0.0	98.0	9.64	28.5	-418	109.0	247.0	134.0		1.4	316.0	5.6	1.3	0.1	0.0	0.0	ND	ND	-21.8	-115	10.1	-14.0	3260-3335	F		
	P82-315		0	0.1	98.0	ND	ND	ND	ND	ND	ND									ND	ND	ND	ND	ND	ND	3620-3335			
	P83-156	GRB-N2	0	0.1	98.5	9.53	31.2	-290	110.0	253.0	141.0	48.4	1.4	337.0	5.8	1.3	0.1	0.0	0.0	ND	ND	-23.6	-113	ND	-14.3	3260-3335	F		
	P83-152	GRB-N2	0	0.0	98.3	9.15	29.4	-310	110.0	254.0	141.0	48.7	1.4	336.0	5.7	1.6	0.1	0.0	0.0	ND	ND	-22.9	-111	ND	-14.2	3260-3335	F		
	P83-157	GRB-N2	0	0.2	98.3	9.20	30.0	-320	123.0	254.0	140.0	50.7	1.5	338.0	5.9	1.3	0.1	0.0	0.0	ND	ND	-22.2	-113	ND	-14.2	3260-3335	F		
	P83-178	GRB-N2	0	0.1	98.4	9.60	29.7	ND	109.0	254.0	140.0	48.3	1.4	328.0	5.7	1.3	0.1	0.0	0.0	ND	ND	-23.4	-112	ND	-13.9	3260-3335	F		
	P83-183	GRB-N2	0	0.1	98.4	9.30	30.2	-320	118.0	254.0	141.0	49.8	1.1	330.0	5.9	1.3	0.1	0.0	0.0	ND	ND	-23.4	-113	ND	-14.9	3260-3335	F		
	P83-154	GRB-N2	0	0.1	98.4	9.33	30.2	ND	120.0	254.0	141.0	50.1	1.7	336.0	5.7	1.3	0.1	0.0	0.0	ND	ND	ND	-114	ND	-14.0	3260-3335	F		
	P83-150	GRB-N2	0	0.1	84.3	9.20	30.5	-300	108.0	253.0	140.0	49.0	1.7	335.0	5.8	1.4	0.1	0.0	0.0	ND	ND	-21.8	-115	ND	-14.0	3260-3335	F		
	P83-266	GRB-N2	0	0.0	98.4	9.30	30.5	-300	117.0	252.0	140.0	50.1	1.4	326.0	5.7	1.3	0.1	0.0	0.0	ND	ND	ND	-114	ND	-14.0	3260-3335	F		
	P83-261	GRB-N2	0	0.0	80.6							48.9	1.1	333.0	5.9	1.4	0.1	0.0	0.0										
DC-15	CSG80-57	SMB-CCI	76	82.5	11.1	8.06	20.6	ND	248.0	15.5	ND	1.1	0.0	112.3	12.1	3.1	0.5	0.3	0.0	-63.6	ND	4.1	-141	ND	-17.1	713-787	P		
	CSG80-87	SMB-MABTON	309	96.7	3.2	8.27	19.7	ND	233.0	17.9	ND	2.0	0.1	109.0	13.6	2.6	1.0	0.5	0.0	-46.5	ND	14.5	-138	ND	-16.8	1003-1072	P		
	CSG80-137	W-Tpr	75	87.9	11.9	9.42	24.7	ND	130.0	46.8	2.0	11.5	0.3	89.1	11.1	1.1	0.0	0.0	0.0	-67.1	ND	0.3	-136	ND	-17.2	1219-1293	P		
	CSG80-176	W-Tr	41	80.0	19.7	9.31	26.6	-240	139.0	35.2	ND	9.5	0.2	97.5	14.2	1.0	0.0	0.0	0.0	-76.5	-264.7	-10.0	-139	ND	-17.1	1357-1390	AL/IG		
	CSG80-135	W-Tfs	37	78.2	21.5	9.43	27.2	-300	149.0	40.1	2.7	9.1	0.2	98.1	14.5	1.5	0.0	0.0	0.0	-69.9	-255.3	-9.4	-137	-1.7	-17.5	1481-1506	AL/IG		
	CSG80-120	W-Tfs	20	65.7	33.8	9.36	23.6	-140	162.0	44.5	1.3	10.9	0.2	102.0	15.9	1.3	0.1	0.1	0.0	-88.4	-264.1	-5.2	-137	ND	-17.4	1540-1593	AL/IG		
	CSG80-131	W-Tfs	0	0.1	98.5	9.54	27.7	-380	152.0	66.0	7.5	11.8	0.3	117.0	13.6	1.0	0.0	0.1	0.0	ND	ND	-17.0	-137	33.8	-16.5	1735-1833	AL/IG		
	CSG80-193	W-Tfs	0	0.4	97.8	9.63	29.0	-420	173.0	70.7	4.8	8.6	0.2	113.0	13.3	1.4	0.0	0.0	0.0	ND	ND	-22.1	-139	ND	-17.4	1834-1887	AL/IG		
	P82-94	GRB-R2	0	1.3	97.5	9.81	18.6	-330	146.0	137.0	107.2	46.3	2.3	271.0	2.9	1.8	0.1	0.2	0.0	ND	ND	-30.7	-124	-16.0	-18.1	4138-4243	AL/IG		
DC-16A	P82-17	SMB-SI	0	0.0	98.5	8.04	24.1	-245	148.0	3.6	4.4	0.5	0.0	46.6	6.4	14.9	3.5			ND	ND	-14.3	-146	33.1	-18.0	928-1021	P		
			0	0.0	98.4																								
	P82-93	SMB-MABTON	1	9.9	88.5	8.86	25.4	-310	184.0	5.1	4.6	0.6	0.1	68.7	11.6	6.0	1.5			ND	ND	-11.8	-145	8.6	-18.3	1395-1568	P		
	P82-19(82-72)	W-Tpr-Tr	126	92.4	7.4	9.14	28.7	-450	150.0	146.0	2.0		0.5	165.0	17.0	2.0	0.1			-44.9	ND	9.4	-138	7.9	-16.4	1760-1828	P		
			126	92.4	7.4																								
			102	87.9	8.8																								
			144	91.9	6.5																								
			144	91.9	6.5																								
	P82-188	W-Tr-Tfs	6	30.3	54.5	9.43	21.5	-405	151.0	172.0	1.2	10.0	0.6	180.0	18.3	1.7	0.1			ND	ND	10.7	-136	ND	-16.0	1892-2000	WINDMI LL (WM)		
			175	94.4	5.5																								
			0	0.7	77.1																								
	P82-124	W-Tfs	23	69.0	30.2	9.39	23.8	-335	144.0	110.0	1.9	13.0	0.6	142.0	20.3	1.7	0.1			-64.0	ND	-2.7	-137	8.9	-16.4	2105-2156	WM		

Table F.1. (contd)

Borehole	Sample	Strat. Interval	CH4, Calc mg/L	CH4 Mole%	N2 Mole%	CH4 mg/L	TEMP (oC)	ORP (mil V)	ALK (mg/L)	Cl- (mg/L)	SO4= (mg/L)	F (mg/L)	B (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Mn (mg/L)	13C(CH4) del C13	D(CH4)	13C(TIC)	D(H2O)	34S(SO4)	18O	Interval (ft)	Method	Comment	
			1	4.5	74.5																								
			0	2.1	75.7																								
	P82-183	W-Tfs	79	86.3	11.1																						2201-2261	WM	
	P82-143	W-Tfs	273	96.2	3.6		9.44	22.4	-425	103.0	ND	6.5	10.8	232.0	34.6	4.9	0.1			-51.8	ND	5.4	-124	9.3	-14.8	2201-2261	WM		
	P82-231	W-Tfs	103	89.4	8.8		9.07	ND	ND	108.0	ND	ND								-52.9	ND	ND	ND	ND	ND	2266-2371	WM		
			156	92.9	6.1																								
			87	87.4	10.2																								
			78	86.2	11.2																								
	P82-322	W-Tfs	300	96.6	3.3		9.11	34.2	ND	90.0	442.0	2.3	24.1	1.4	324.0	32.0	3.9	0.1		-46.9	ND	ND	-110	ND	-12.1	2476-2559	P		
			536	98.0	1.9																								
			522	98.0	1.9																								
			522	98.0	1.9																								
	P82-339	W-Tfs	816	98.7	1.2		ND	26.1	ND	ND	ND	ND								ND	ND	ND	ND	ND	ND	2585-2632	P		
			1438	99.0	0.7																								
			837	98.7	1.2																								
	P82-419	W-GRB	599	98.3	1.7		ND	23.4	ND	ND	ND	ND								ND	ND	ND	ND	ND	ND	2670-2822	P		
	P82-430	W-GRB	560	98.0	1.8		9.46	23.4	-390	150.0	414.0	8.4	27.6	2.6	346.0	20.0	2.7	0.1		-44.8	ND	5.1	-114	11.2	-11.5	2671-2730	WM		
			577	98.2	1.7																								
	P83-29	GRB-RC					9.51	25.0	-350	141.0	422.0	5.5	26.6	2.6	335.0	24.3	2.6	0.1	0.1	0.0	-47.8	ND	ND	-105	ND	-11.8	2836-2946	WM	
			629	98.4	1.6																								
			672	98.5	1.5																								
DC-18	B86-166	W-Tpr	12	49.2	50.8	11	9.18	21.5	-215	154.0	26.4	0.2	3.5	0.1	84.3	12.4	0.7	0.2	0.0	0.0	ND	ND	-12.5	-140	ND	-18.1	698-760	P	
			10	45.4	54.6	11																							
	B86-198	W-Tpr-Tr	11	49.0	51.0	12	9.05	22.3	-350	151.0	26.4	0.5	3.2	0.1	89.9	11.7	0.8	0.2	0.0	0.0	ND	ND	-11.4	-137	ND	-18.2	779-822	P	
			11	49.0	51.0	12																							
	B86-210	W-Tr-Tr	11	48.5	51.5	11	9.03	22.8	-390	151.0	27.0	0.5	3.4	0.1	83.4	12.1	0.9	0.2	0.0	0.0	ND	ND	-12.1	-138	ND	-17.4	960-988	P	
			11	48.3	51.7	11																							
	B86-263	W-Tfs	13	52.9	47.1	11	9.31	24.5	-330	155.0	26.2	1.9	3.3	0.1	84.9	11.5	0.8	0.1	0.0	0.0	-79.5	-241.0	-12.6	-142	2.6	-17.8	1149-1373	P	
			12	50.2	49.8	10																							
	B87-001	W-Tfs	18	59.7	40.3	13	9.01	25.0	-380	157.0	30.7	0.8	4.3	0.1	89.5	12.4	1.1	0.1	0.0	0.0	ND	ND	-9.5	-137	ND	-17.6	1520-1561	P	
			19	61.8	38.2	14																							
DC-19C	P84-53	W-Tr-Tfs	2	14.4	69.1		8.60	28.7	-370	125.0	180.0	21.9	15.1	0.8	188.0	19.4	1.7	0.2	0.2	0.0	ND	ND	ND	-128	-6.1	-15.2	1826-1952	P	
	P84-40	W-TFS	23	68.1	29.6		9.00	24.0	-100	144.0	181.0	9.9	14.6	0.8	191.0	20.7	2.0	0.1	0.3	0.0	ND	ND	-4.1	-129	6.0	-15.5	2421-2468	P	
			15	57.9	40.6																								
			7	40.6	58.5																								
	P84-75	GRB-COH	11	50.5	45.7		8.85	24.4	-250	117.0	202.0	14.8	15.8	0.7	190.0	11.6	1.9	0.2	1.4	0.0	ND	ND	2.7	-121	6.4	-14.7	3008-3105	P	
			10	47.8	48.9																								
	P84-86	GRB-UMT	16	60.0	37.4		8.95	23.3	-330	113.0	185.0	4.6	14.6	0.6	177.0	6.2	2.0	0.3	1.0	0.0	ND	ND	10.0	-130	3.9	-15.1	3586-3667	P	
			14	56.0	41.2																								
DC-20C	P84-9	W-GRB	23	68.8	30.4		8.95	32.3	60	132.0	164.0	7.8	10.6	0.6	171.0	17.4	1.6	0.1	0.6	0.0	ND	ND	1.3	-128	5.2	-15.8	1581-3781	P	
			9	46.3	53.0																								
DC-22C	P84-105	W-GRB	50	82.4	16.7		9.15	30.5	-310	114.0	103.0	2.2	7.6	0.4	126.0	17.0	1.9	0.1	0.1	0.0	ND	ND	7.3	-133	9.8	-16.5	1709-3960	P	

Table F.1. (contd)

Borehole	Sample	Strat. Interval	CH4, Calc mg/L	CH4 Mole%	N2 Mole%	CH4 mg/L	pH	TEMP (oC)	ORP (mil V)	ALK (mg/L)	Cl- (mg/L)	SO4= (mg/L)	F (mg/L)	B (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Mn (mg/L)	13C(CH4) del C13	D(CH4)	13C(TIC)	D(H2O)	34S(SO4)	18O	Interval (ft)	Method	Comment		
DC-23GR	B86-133	W-Tpr	80	85.2	10.8	120*	9.33	29.0	-255	124.0	133.5	2.5	7.0	0.2	134.8	20.2	4.1	0.2	0.0	0.0	-35.2	-134.0	9.0	-137	8.0	-16.9	1345-1425	P			
			83	85.7	10.5	110+																									
	B86-141	W-Tr-Tfs	89	83.6	9.6	150*	9.25	29.7	-355	110.0	117.0	4.5	6.3	0.2	120.2	19.3	3.8	0.2	0.0	0.0	-55.9	-220.0	8.3	-134	10.0	-17.6	1575-1635	P			
	B86-181	W-Tfs	<1	1.2	98.8	0	9.92	26.5	-410	167.0	64.6	1.4	16.9	0.4	127.8	12.2	2.5	0.2	0.0	0.0	ND	ND	-23.5	129	ND	-16.3	2155-2216	P			
	B86-274	GRB-UMT					9.49	23.0	-275	135.0	305.0	5.6	25.6	0.8	281.7	12.7	2.5	0.2	0.1	0.0	ND	ND	-25.8	-115	9.7	-13.9	3275-3384	P			
DNR-BR-01	B86-310	W	21	63.9	36.1	15	8.05	24.8	-155	131.0	4.5	ND	0.7	0.1	25.3	5.8	15.4	9.6	0.0	0.0	ND	ND	-9.9	-133	ND	-16.8	603-1145	P			
ENYEART	P84-166	W	6	31.5	55.4		8.05	22.0	-210	147.0	4.7	1.8	1.0	0.0	26.3	6.4	18.1	11.2	0.1	0.1	ND	ND	-12.3	-137	ND	-16.9	935-1092	F			
MARLEY-4	B86-295	W	11	48.1	51.9	8	8.14	23.0	45	128.0	4.0	ND	0.6	0.1	23.8	5.1	15.5	9.7	0.0	0.0	ND	ND	-12.1	-137	ND	-16.4	724-1377	P			
MCGEE	P82-7	W-Tpr	10	44.0	46.0		7.66	26.1	-300	145.0	4.6	ND	0.7	0.0	27.7	7.3	15.6	8.3	0.1	0.1	ND	ND	-11.2	-146	ND	-17.9	691-978	F			
			5	33.4	64.8		7.68	26.3	-365	139.0	4.8	ND	0.7	0.0	29.7	8.0	16.6	8.7	0.1	0.1	ND	ND	-11.1	-140	ND	-18.0	692-925	F			
	P82-263	W-Tr	5	34.4	64.2		7.70	26.7	-250	139.0	4.1	ND	0.6	0.0	27.0	7.0	16.4	8.6	0.2	0.0	ND	ND	-11.1	-144	ND	-17.9	1028-1096	F			
			5	34.5	64.3																										
	P82-397	W-Tfs	5	33.6	65.2		8.11	28.2	-200	142.0	4.8	ND	0.6	0.0	28.6	7.5	16.5	9.0	0.1	0.1	-49.9	ND	-11.4	-144	ND	-17.9	1099-1167	F			
			5	33.7	65.1																										
			3	21.2	77.1																										
	P82-424	W-Tfs	4	27.7	71.0		7.45	30.5	-170	146.0	5.1	ND	0.7	0.0	28.1	7.7	17.3	9.5	0.2	0.0	ND	ND	-11.6	-146	ND	-18.0	1320-1378	F			
			5	31.8	66.9																										
			5	32.0	66.7																										
	P82-436	W-Tfs	4	28.7	70.0		7.80	31.7	-100	148.0	4.2	0.2	0.7	0.0	28.2	7.8	17.2	9.2	0.1	0.0	ND	ND	-11.5	-148	ND	-18.0	1404-1440	F			
	P83-32	W-Tfs	4	26.6	71.0		7.56	20.4	-150	148.0	4.6	0.1	0.6	0.0	27.4	7.8	17.7	8.5	0.5	0.1	ND	ND	-11.2	-145	ND	-18.4	1443-1483	F			
	P83-83	W-Tfs	4	28.4	70.3		8.16	31.8	-230	151.0	5.0	0.1	0.6	0.0	28.7	7.8	18.0	9.3	0.1	0.0	ND	ND	-11.5	-146	ND	-18.3	1581-1680	F			
	P83-188	W-Tfs	4	26.5	72.5		8.00	31.8	-210	150.0	4.8	ND	0.6	0.0	31.8	9.2	17.8	5.8	0.1	0.0	ND	ND	-11.0	-145	ND	-18.8	1674-1750	F			
	P83-331	GRB-RC	13	54.2	44.1		9.05	27.8	-350	185.0	7.5	1.6	3.4	0.1	87.1	8.1	1.1	0.1	0.1	0.0	ND	ND	-4.1	-143	ND	-17.4	1991-2092	WM			
	P83-476	GRB-COH	12	50.3	44.0		9.40	26.6	-300	181.0	7.6	0.4	3.5	0.0	90.9	8.4	0.9	0.1	0.1	0.0	ND	ND	-4.5	-142	ND	-17.6	2188-2337	WM			
	P83-513	GRB-COH	3	19.1	75.1		9.50	27.9	-340	176.0	48.4	1.1	11.0	0.1	120.0	9.7	1.2	0.1	0.1	0.0	ND	ND	ND	-144	ND	-17.5	2393-2524	WM			
P84-24	GRB-UMT	5	31.0	67.9		9.45	25.8	-410	208.0	48.4	6.2	9.3	0.1	130.0	10.2	1.0	0.1	0.2	0.0	ND	ND	-10.7	-145	ND	-17.4	2854-3123	WM				
CSG80-64	GRB-COH												0.7	0.0	29.7	8.9	16.6	9.3	0.1	0.1	-51.6		-11.2	-142	ND	-17.3	692-925	F			
RRL-02	P82-65	W-Tpr-Tr	52	83.3	16.2		9.32	21.8	-385	155.0	122.0	2.0	8.6	0.4	141.0	15.5	1.9	0.1	0.4	0.0	ND	ND	8.5	-136	ND	-16.0	1735-1773	AL/IG			
			3	19.8	62.7		9.71	23.4	-290	165.0	403.0	4.2	20.0	3.5	337.0	13.8	2.2	0.1	0.1	0.0	ND	ND	15.3	-116	7.8	-11.6	3247-3344	WM			
				689	98.2	1.5																									
	P84-7	GBR-COH	797	98.7	1.3		9.60	19.5	-365	149.0	416.0	1.0	14.0	2.9	353.0	13.5	2.4	0.1	0.1	0.0	ND	ND	19.7	-112	11.2	-10.8	3247-3344	WM			
	P82-364	GRB-UMT	589	97.9	1.7		9.41	29.4	-220	136.0	451.0	1.7	18.2	3.4	355.0	9.4	1.6	0.1	0.1	0.0	-37.8	ND	16.9	-110	2.1	-11.2	3568-3781	WM			
			316	96.7	3.1																										
			505	97.8	2.0																										
			532	97.9	1.9																										
				447	97.2	2.2																									
	P82-309	GRB-UMT(FZ)	275	96.2	3.6		9.34	25.9	ND	132.0	384.0	3.5	17.2	3.1	336.0	8.5	2.8	0.2	0.1	0.0	-38.4	ND	ND	ND	ND	ND	3781-3827	WM			
P82-456	GRB-HMG	931	98.9	1.1		9.78	22.3	-300	135.0	455.0	2.4	20.1	3.5	364.0	5.9	1.8	0.1	0.1	0.0	-38.3	ND	16.4	-114	5.8	-11.1	3837-3889	WM				
		610	98.3	1.6																											
			408	97.5	2.4																										

Table F.1. (contd)

Borehole	Sample	Strat. Interval	CH4, Calc mg/L	CH4 Mole%	N2 Mole%	CH4 mg/L	pH	TEMP (oC)	ORP (mil V)	ALK (mg/L)	Cl- (mg/L)	SO4= (mg/L)	F (mg/L)	B (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Mn (mg/L)	13C(CH4) del C13	D(CH4)	13C(TIC)	D(H2O)	34S(SO4)	18O	Interval (ft)	Method	Comment	
RRL-02C	B86-313	GRB-N2	662 637	98.3 98.3	1.5 1.6	580*																								
RRL-06B	P83-25	GRB-UMT	478 361	97.8 96.5	2.1 2.7		ND	ND	ND	ND	ND	ND									ND	ND	ND	ND	ND	ND	3708-3823	P		
RRL-14	P82-403	GRB-COH	606 622	98.3 98.4	1.7 1.6		9.48	22.9	-50	195.0	375.0	16.8(BAD)	24.3	2.3	336.9	24.7	2.1	0.1	0.1	0.0	-44.1 -43.9	ND	ND	ND	ND	ND	3017-3147	WM		
	P84-11	GRB-COH	493	97.9	2.0		ND	ND	ND	ND	ND	ND									ND	ND	ND	ND	ND	3077-3140				
	P83-151	GRB-COH	457	97.5	2.2		ND	ND	ND	ND	ND	ND									ND	ND	ND	ND	ND	3294-3814				
	P83-49	GRB-UMT	525 519	98.0 97.5	1.9 1.9		ND	ND	ND	ND	ND	ND									-47.9	ND	ND	ND	ND	ND	3715-3814	WM		
STEM-1	B86-31	W-Tpr-Tfs	2	15.0	85.0	2	7.80	19.5	-150	157.0	4.9	0.2	0.6	0.1	25.2	5.7	20.3	12.6	0.0	0.0	ND	ND	ND	ND	ND	469-970	P			
	B85-252	W-Tpr-Tfs	1	9.8	90.2	1																	-14.0	-130	-4.4	-17.1	469-970	P		
STEM-2	B86-354	W-Tpr-Tfs	5	27.5	72.5	3	8.05	19.5	-25	152.0	4.8	ND									ND	ND	-13.4	-148	ND	-17.2	565-1002	P		
	B86-19		3	26.6	73.4	3							0.6	0.1	25.1	5.9	19.7	12.1	0.1	0.0			-13.4	-134	ND	-17.3	565-1002	P		

*Based on gas flow rate measurement from separator barrel with appropriate temperature, pressure, and compositional correction.
 †Downhole pressurized fluid sample collected and maintained at in situ hydrostatic pressure (-40 atm) until analyzed by purge and trap gas chromatography.